Sociodemographic and Clinical Variation in Bone Metastasis and Survival Among Distant-Stage Lung Cancer Patients in Louisiana

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Introduction

Burden: Lung cancer, specifically stage IV, remains the leading cause of cancer death in the United States and exerts a disproportionate burden in high-incidence regions such as Louisiana.
Problem: Bone metastasis (BM) affects more than one-third of patients with stage IV lung cancer, often leading to skeletal-related events (SREs), such as pathologic fracture and severe pain, which greatly diminish quality of life and increase mortality.
Gap: Few studies have examined how sociodemographic and clinical factors influence BM development and survival outcome, particularly in high-burden regions with a diverse population like Louisiana.

Objectives

1. Assess sociodemographic, clinical, and tumor-related predictors of bone metastasis at diagnosis among patients with stage IV lung cancer
2. Survival differences by metastasis site (bone-only vs. bone + others vs. non-bone) in stage IV lung cancer

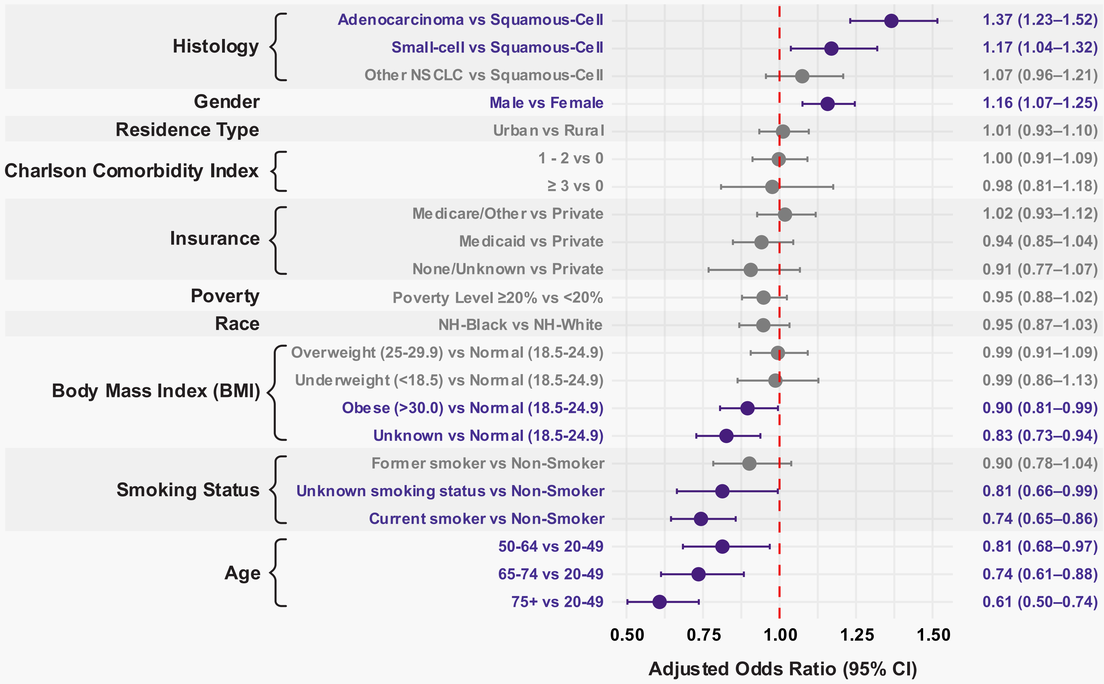
Methods

Design: We conducted a population-based retrospective cohort study of Louisiana patients diagnosed with distant-stage lung cancer in 2011-2021 using the Louisiana Tumor Registry (LTR).
Exclusions: Autopsy/death certificate only, missing key data, and prior or synchronous primary cancers.
Exposures: Sociodemographic factors (age, sex, race, insurance, poverty level, urban/rural), clinical factors (smoking status, BMI, Charlson Comorbidity Index), tumor characteristics (histologic subtype, grade, stage, metastasis site), and treatment (survival analysis only)
Outcomes: BM at diagnosis; overall and cause-specific death (OD and CSD) through 2022
Analysis: Associations between predictors and BM were assessed using multivariable logistic regression to estimate adjusted odds ratios (ORs) with 95% confidence intervals (CIs). Kaplan–Meier methods and log-rank tests compared survival distributions across metastasis groups. Multivariable Cox proportional hazards models estimated hazard ratios (HRs) and 95% CIs for OD and CSD, adjusting for sociodemographic, clinical, tumor, and treatment variables. Two-sided $p < 0.05$ was considered significant. Analyses were performed in R v4.5.1.

Results

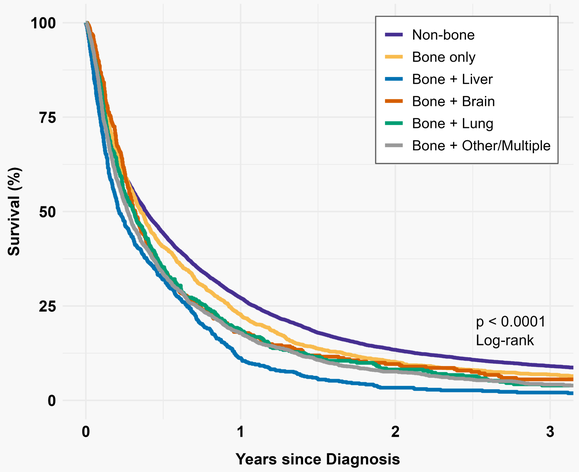
- N = 13,233; median age of 65 years (IQR: 58–72)
- 57.2% male; 70.5% Non-Hispanic White; 70.4% Urban
- 35.9% presented with any bone involvement
- Median follow-up time was 4.8 months (IQR 0.0–9.6)
- Any BM predicted 35% higher risk of OD (HR=1.35; 95% CI: 1.30-1.41) and 40% CSD (HR=1.40; 95% CI: 1.35-1.46)

Factors Associated with Bone Metastasis at Diagnosis in Stage IV Lung Cancer

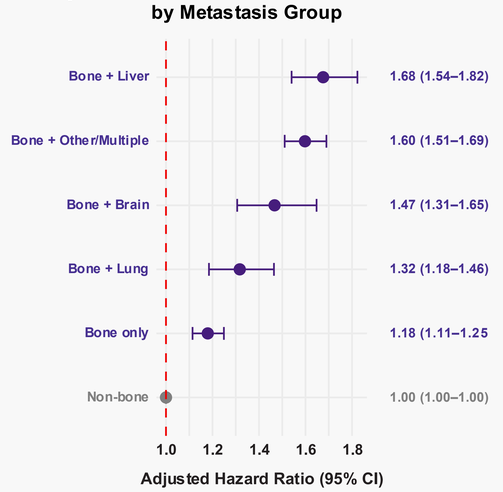


Young age, male sex, and adenocarcinoma or small-cell tumors were associated with increased odds of BM at diagnosis among stage IV lung cancer patients, whereas current smoking and obesity were associated with decreased odds. Survival analysis revealed that BM, especially in combination with other metastatic sites, was associated with significantly increased overall and cause-specific mortality, even after adjusting for sociodemographic, clinical and tumor-related factors. Most survival curves diverged within the first 6 months, and log-rank testing confirmed significant differences. Multivariable Cox modeling showed that BM independently predicted greater mortality risk, while among those with BM, older age, male sex, smoking, lack of insurance, and small-cell or other non-small-cell tumors were associated with poorer survival, whereas overweight BMI and adenocarcinoma histology were associated with improved outcomes (not shown).

3-Year Overall Survival by Metastasis Group



Adjusted Hazard Ratios for Overall Survival by Metastasis Group



For simplicity and clarity, only overall survival outcomes are shown here. Cause-specific survival curves and hazard ratios are similar in pattern and magnitude.

Discussion

1. In this large population-based cohort of stage IV lung cancer patients, BM independently predicted significantly poorer overall and cause-specific survival in Louisiana, especially when combined with other metastatic sites.
2. Given the already poor prognosis of distant-stage lung cancer, with a median survival typically between 4 and 8 months, BM further compounds mortality risk. Survival curves diverged within the first 6 months, underscoring the early and severe impact of BM.
3. Younger age, male sex, and adeno-carcinoma or small-cell tumors were associated with increased odds of BM, while current smoking was unexpectedly linked to a lower likelihood of BM. This inverse association may reflect competing risks or shorter survival limiting the opportunity for bone spread rather than a protective effect. Smoking is associated with aggressive tumor biology and rapid progression, which may favor earlier spread and detection of metastases to visceral sites with less time for BM to develop prior to initial diagnosis.
4. Among patients with BM, survival disparities by age, sex, insurance, smoking status, BMI, and histology persisted after adjustment, suggesting differences in access to care, treatment, or disease severity.
5. These findings highlight the substantial burden of BM in advanced lung cancer and the need for further research into biological mechanisms and health inequities contributing to outcome variation.

Conclusion

This study identified sociodemographic and clinical characteristics associated with bone metastasis and survival in stage IV lung cancer. Bone involvement, particularly as part of multi-site disease, was linked to markedly higher mortality in a population already facing poor prognosis. Further research integrating detailed clinical, treatment, and molecular data is needed to refine risk stratification and inform equitable, patient-centered care strategies for advanced lung cancer.

Acknowledgements

This research was supported by the Cancer Epidemiology Education in Special Populations (CEESP) Program at the CUNY School of Medicine, through funding from the National Cancer Institute (NCI) under R25 grant number R25CA112383. We gratefully acknowledge the Louisiana Tumor Registry (LTR) for providing the de-identified cancer patient data used in this study. LTR is funded by NCI-SEER (HHSN261201800007I/-HHSN26100002) and CDC-NPCR (5 NU58DP007112-03-00)

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